- **Title:** **Identifying and characterizing cluster members.**
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- **Last update: 2019 Nov 1st.**

- **VO-Tools:** Clusterix, TOPCAT, VOSA

- **Scientific background:** Open clusters (OCs) are coeval groups of stars formed from the same molecular cloud and, thus, having the same age and initial chemical composition. This makes them ideal targets to study the formation and evolution of stellar objects.

  The determination of the mean properties of open clusters requires prior knowledge of their members to optimise the costly process of obtaining and reducing high resolution spectroscopic data on a large scale. Hence, a precise identification of the stars that compose a cluster is critical to accurately determine the kinematic and fundamental parameters of the clusters (age, total mass, etc.), which are essential for studies of Galactic dynamics.

  In this tutorial we will work with M67, an old cluster (~3.6 Gyr) at about 900 pc with a near solar metallicity and low reddening. M67 is one of the best studied open clusters, considered a cornerstone of stellar astrophysics and used as a calibrator in many surveys. However there is no study covering a large area in spite of some studies on its corona showing that it is an extended cluster. Gaia Collaboration et al. (2018b) studied an area of 1 deg with G <20 and found 1520 members.

  Detailed information on Clusterix is given in Balaguer-Núñez et al. (https://arxiv.org/abs/1910.07356)

- **Using Clusterix to estimate cluster membership probabilities.**

  - Go to Clusterix web server → http://clusterix.cab.inta-csic.es/clusterix/

  - Fill in the fields as shown in Figure 1. Click *"Search"*

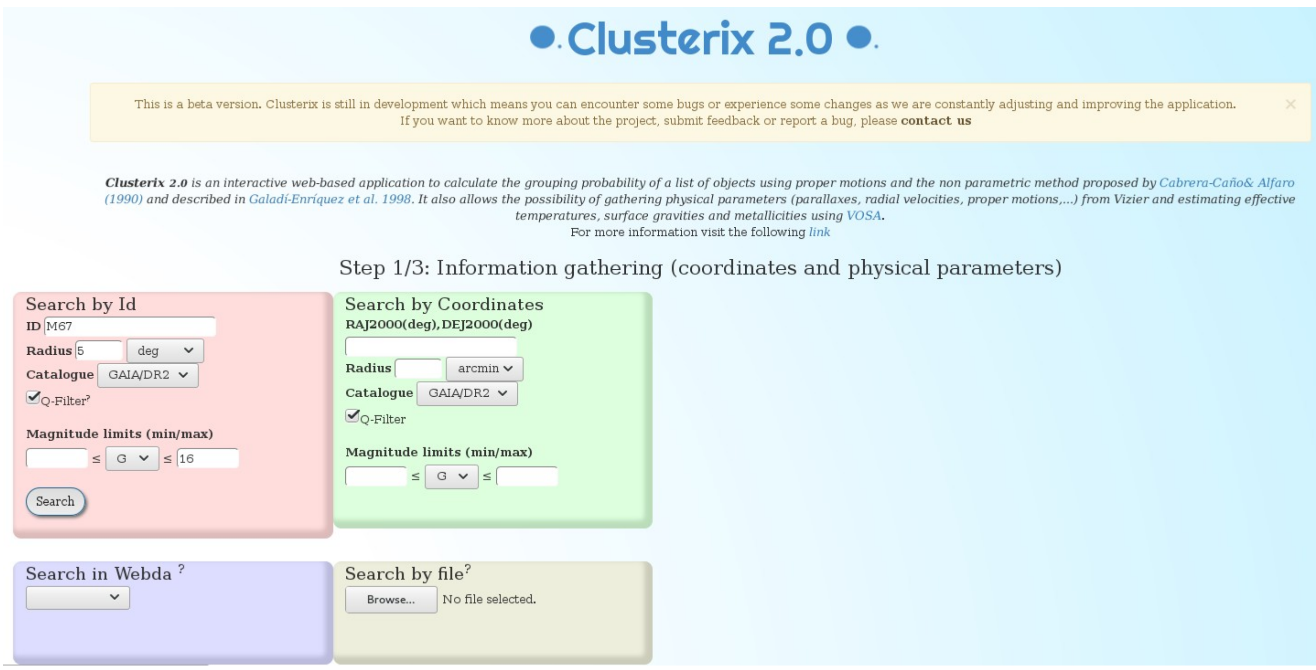


Figure 1

- The result of the query is visualized using Aladin, where the objects obtained from the query are plotted as red diamonds. The individual representation of objects is limited to 40 000. If the result of a query exceeds this amount, then just a yellow circle enclosing the search region is drawn. (Figure 2)

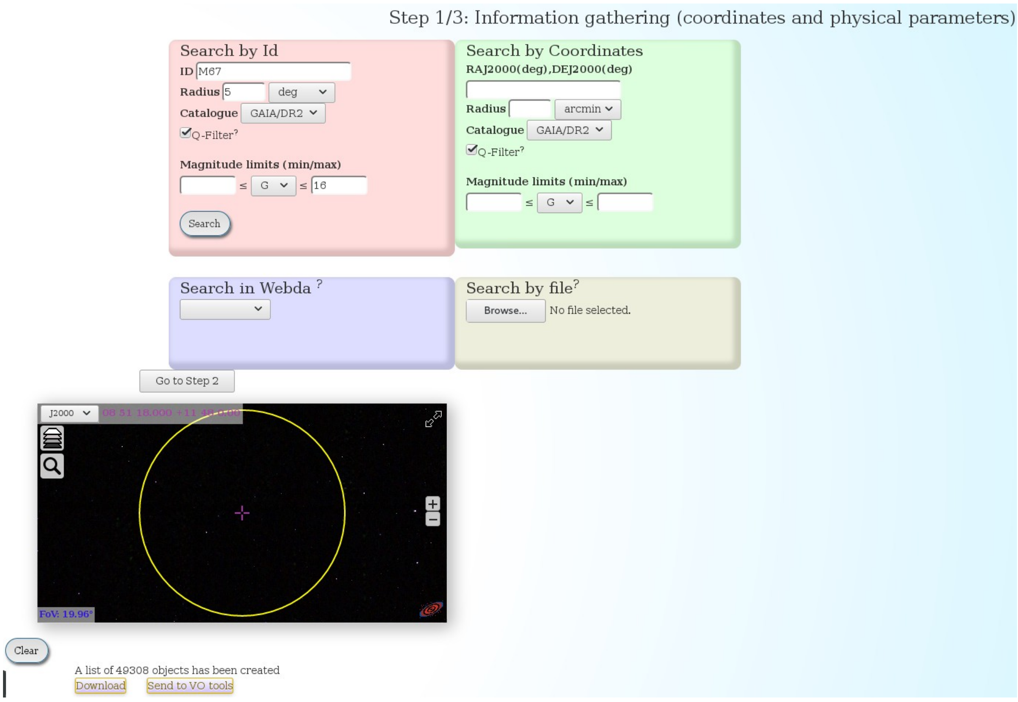


Figure 2

- Click on “Go to Step 2” to proceed to **Step2.**

  - The second step is to select the *cluster+field* (c+f) and *only field* (f) regions. The definition of these areas is one of the most critical decisions to take by the user, and Clusterix offers several ways to interactively shape and reshape these areas. The simplest option relies on mouse clicks to draw circles that define the *c+f* and *f* regions. The system also includes an easy way to set up a “clean” area around the c+f region to avoid a region that could still have a significant number of cluster members.

    Alternatively, the user can specify the circular areas directly writing their parameters (in decimal degrees) in the corresponding boxes (format: ”ra,dec,radius;”). For this tutorial, fill in the fields with the values given in Figure 3.

    Also, in this second step, the user can customize the following parameters:

    - Proper motion limits. Maximum value of the total proper motion (to discard objects that clearly cannot belong to the expected cluster population), and maximum value of the total proper motion error (to remove data of dubious quality).

    - Magnitude range to further limit the selection done in Step 1.

    - Smoothing parameter. Clusterix 2.0 proposes a default value for the smoothing parameter *h.* It represents the radius of the kernel windows used to compute the frequency functions. A large value would blur out the details of the frequency functions, while a small value would yield noisy results.

- Fine tuning values. To avoid meaningless probability values, Clusterix 2.0 restricts the probability calculations to stars with densities γ times above the noise.

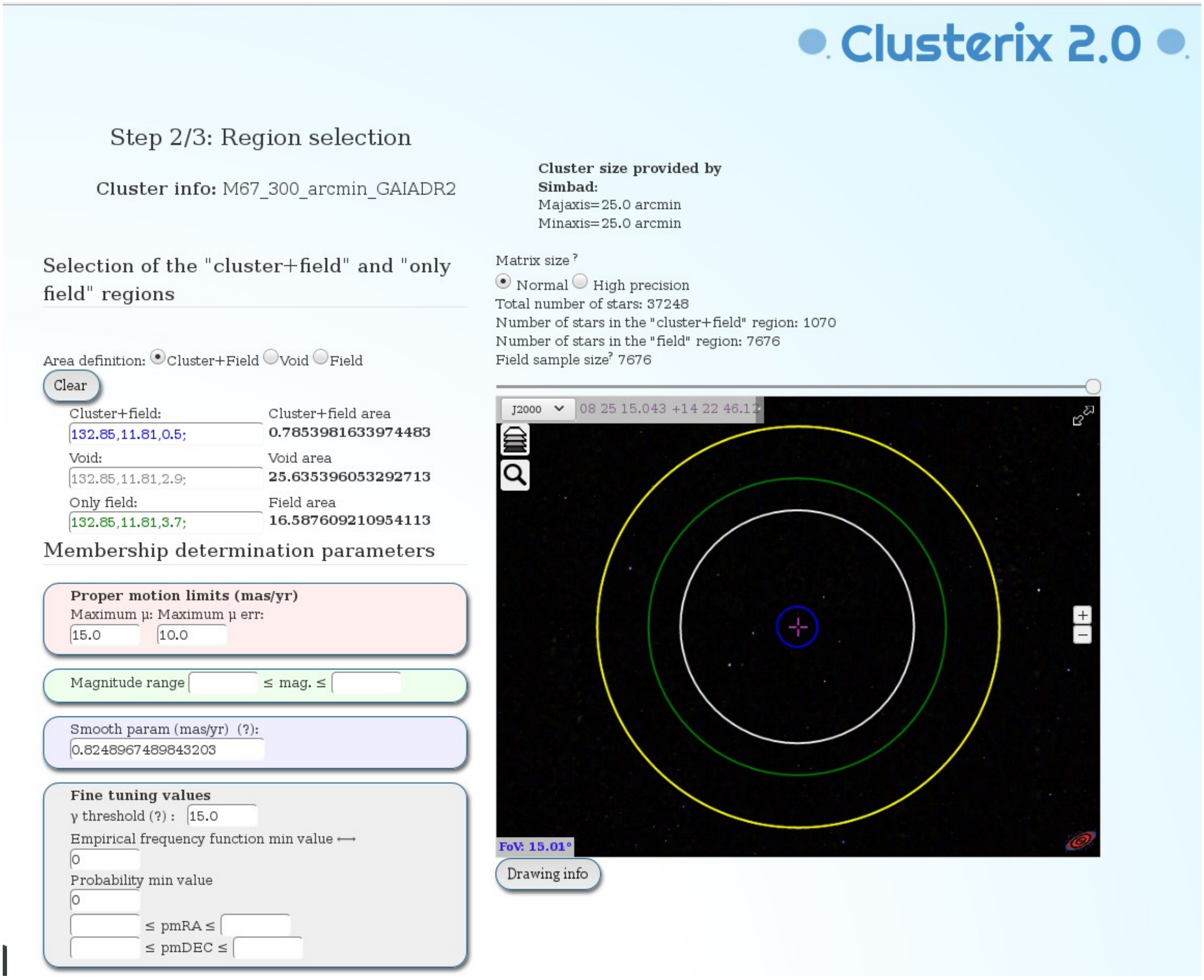


Figure 3.

- The distribution functions computed using the parameters given in Figure 3 are shown in Figure 4.

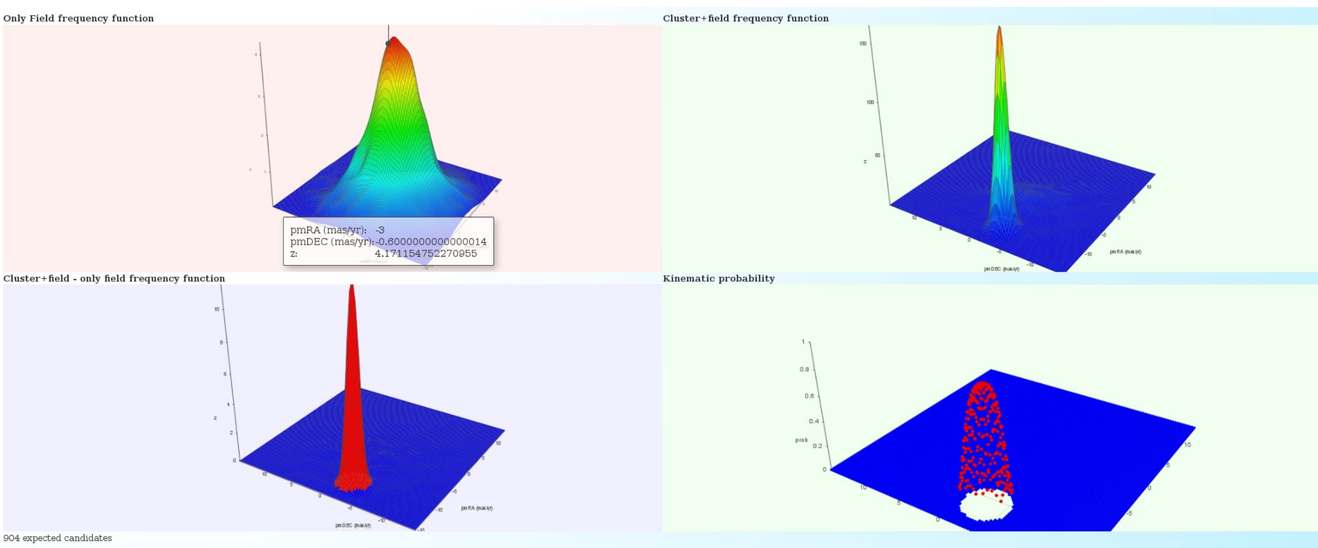


Figure 4

- Once the distribution functions have been computed you can go to Step 3 by clicking “Go to Step 3”. Here you can find a summary of the main parameters used in the query as well as the list of cluster members.Those with the highest probabilities are ranked first. (Figure 5).

```
#   Results were retrieved using Clusterix software
#   http://clusterix.cab.inta-csic.es/
#   In case of problems, please, report to: clusterix_archive_support@cab.inta-csic.es
#
#   Labels:
#
#       STAR_NO identificator of star retrieved from the input data
#       RA      right ascension of a star
#       DEC     declination of a star
#       PM_RA   proper motion in alpha
#       PM_DEC  proper motion in delta
#       PROB    probability that star belongs to evaluated open cluster
#       FLAG    M=Membership   NM=No membership
#
#   Parameters:
#
#       CLUSTER INFO: M67_300_arcmin_GAIADR2
#       PROPER MOTION CUTOFF: 15.00 mas/yr
#       PROPER MOTION ERR CUTOFF: 10.00 mas/yr
#       SMOOTH PARAMETER: 0.82
#       GAMMA FACTOR: 15.00
#       QUERY MIN MAG (STEP 1):
#       QUERY MAX MAG (STEP 1): 16
#       FILTERED MIN MAG (STEP 2):
#       FILTERED MAX MAG (STEP 2):
#
#       Boundaries can be circles (Ra(J2000)-center,Dec(J2000)-center, radius degrees) or
#       polygons (Ra,Dec Ra,Dec Ra,Dec ...). Each boundary is separated by ;
#
#       CLUSTER BOUNDARIES:
#       132.85,11.81,0.5;
#
#       FIELD BOUNDARIES:
#       132.85,11.81,3.7;
#
#       VOID BOUNDARIES:
#       132.85,11.81,2.9;
#
#       NUM STARS: 49304
#
#       EXPECTED NUMBER OF MEMBERS: 904
#
#       For Webda clusters, STAR_NO is the merge of the Data source reference and the star number: Ref_Star
#
#       Region values: F = star was inside a "only field" region
#                      C = star was inside a "cluster+field" region
#                      V = star was outside the selected regions

Highest probability results sample (only 50 first shown).
```

##STAR_NO	RAJ2000	DECJ2000	pmRA	epmRA	pmDEC	epmDEC	Pll	ePll	BP	eBP	RP	eRP	G	eG	RV	eRV	PROB	Region
31720	132.970320	11.735483	-11.156	0.074	-3.005	0.049	1.1198	0.0434	15.9063	0.0028	14.8353	0.0014	15.4447	3.0E-4	NaN	NaN	0.9134696	V

Figure 5.

- At the top left of this page there is a button “Send to VO tools”. Click here to send the table with the membership probabilities to TOPCAT (NOTE: TOPCAT must be open. SAMP broadcasting requires user authorization. A new window (“SAMP Hub Security”) may pop up asking for authorization. If so, click “Yes”.). After this, a new table with 49 304 rows will be created.

- **Using TOPCAT to visualize the results**
  - Once the table has been uploaded, we can visualize the results in TOPCAT by doing this:
    - In the TOPCAT main window → *Graphics / Plane Plot.* A new window *“Plane Plot”* will pop up.
    - Select the columns to be plotted (X: RA_PM; Y: DEC_PM). Use the mouse to center / zoom in / zoom out the graphic. You will clearly see the M67 overdensity in the proper motion parameter space (Figure 6).

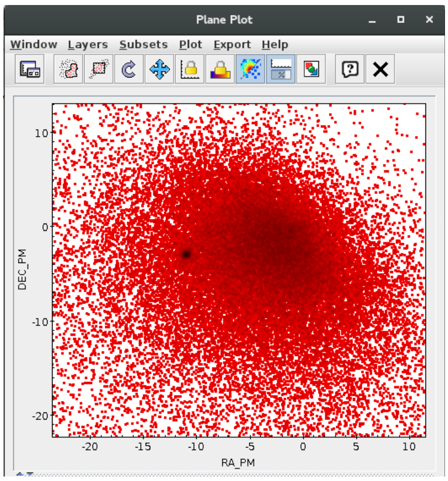


Figure 6.

- Let's now select the M67 members according the probabilities calculated by Clusterix.

  - In the TOPCAT main window → *View / Row Subsets*. A new window *"Row Subsets"* appears.

  - In the Row Subsets window → *Subsets / New subset*. A new window *"Define Row Subset"* pops up.

  - In the Define Row Subset window → *Subset name: filt; Expression:prob>0.8*. Click "OK". (Figure 7)

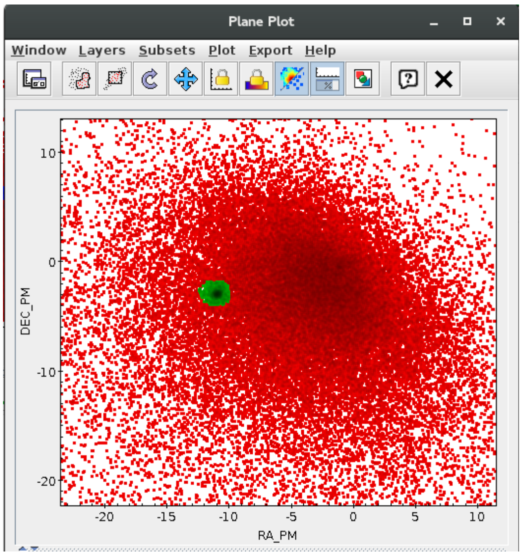


Figure 7

  - Alternatively, you can build an histogram with the probability values (TOPCAT main window → *Graphics / Histogram Plot.* A new window *"Histogram Plot*" appears → Select the column to be plotted (X: Prob)) and use it to define your probability cut (Figure 8).

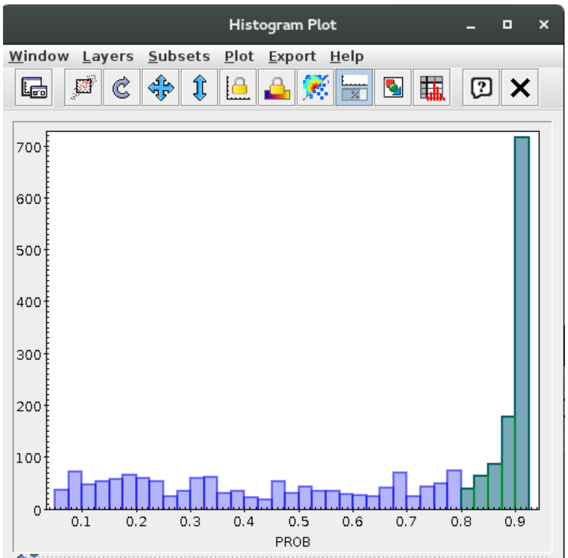


Figure 8

- Let's build now a colour-magnitude diagram with all the sources in the selected field.
    - In the TOPCAT main window → *Graphics / Plane Plot.* A new window *"Plane Plot"* will pop up.
-
    - Select the columns to be plotted (X: BP-RP; Y: Gmag).
    - Click Axes → Tick "Y Flip". (Figure 9)

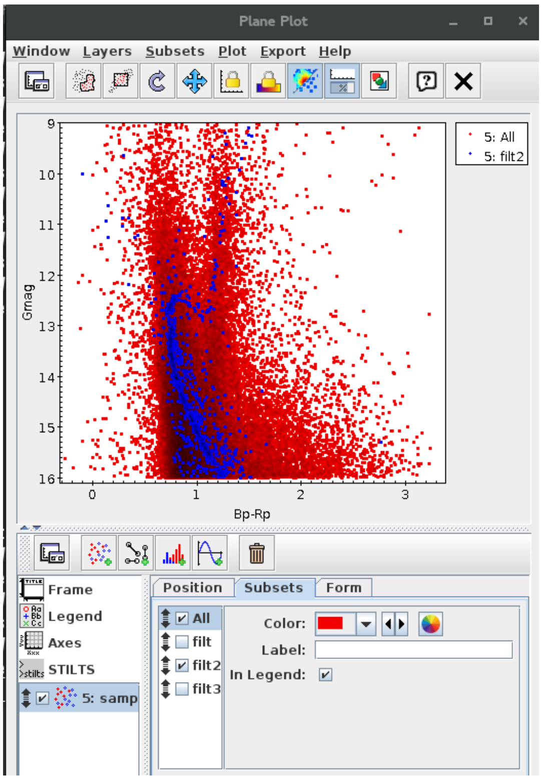


Figure 9.

- The membership selection made by Clusterix is based on proper motions only. Additionally, you can use the information on parallaxes to refine the selection.
    - Graphics / Histogram Plot (X: PLL). In the "Histogram Plot" window, tag "Subset", deselect "All" and tick "filt" (Figure 10).

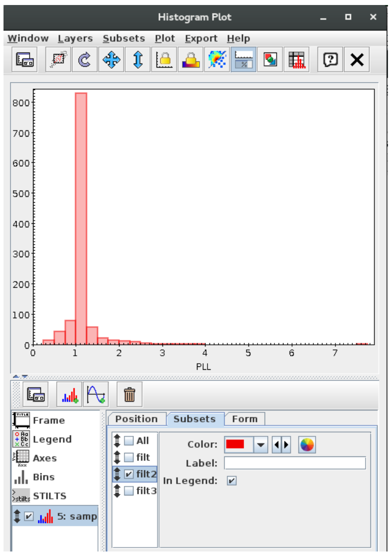


Figure 10

- In the TOPCAT main window → *View / Row Subsets*. A new window *“Row Subsets”* appears.
- In the Row Subsets window → *Subsets / New subset*. A new window *“Define Row Subset”* pops up.
- In the Define Row Subset window → *Subset name: filt2; Expression:filt&&pll>0.8&&pll<1.4*. Click “OK”. The cluster sequence is now clearly seen in the colour-magnitude diagram (Figure 11).

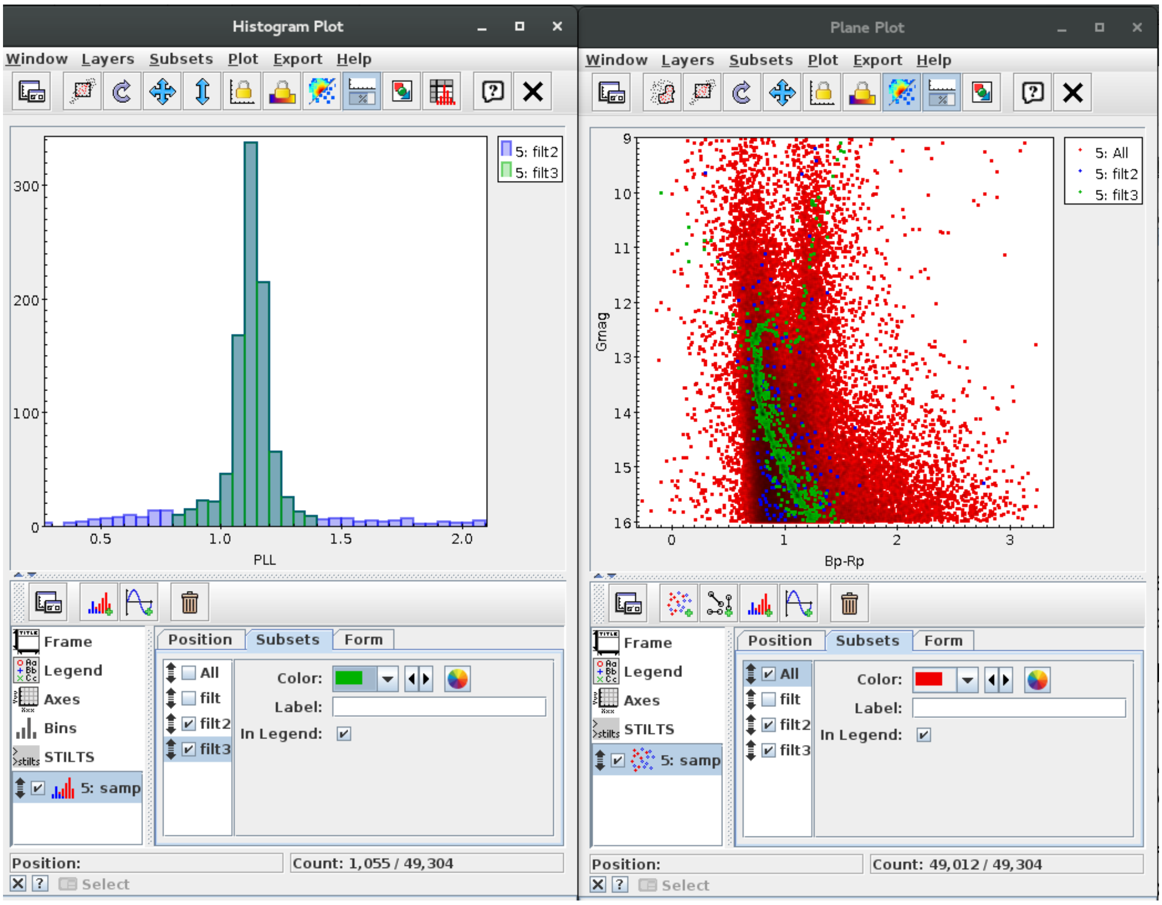


Figure 11

- The next step is to send the selected list of objects to VOSA to estimate their effective temperatures, luminosities and radii. →
  - In the TOPCAT main window → *Row Subset: filt2* (to keep the filtered sources only).
  - In the TOPCAT main window → *Views / Column info.* A new window *“Table Columns”* appears.
  - In the *Table Columns* window → *Colums / Hide all columns.* Then, in *the “Visible” column, tick STAR_NO, RA, DEC*
  - In the TOPCAT main window File / Save Table(s) or Session / Filestore Browser → File Name: clusterix4vosa.txt. Output format: ascii → Click *“OK”.* The file will contain 939 rows.

- **Using VOSA to estimate physical parameters**
  - Step 1.- Go to http://svo2.cab.inta-csic.es/theory/vosa/
  - Step 2.- To use VOSA you need to be registered. Click on “Register” and fill in the fields (email, name and passwd).

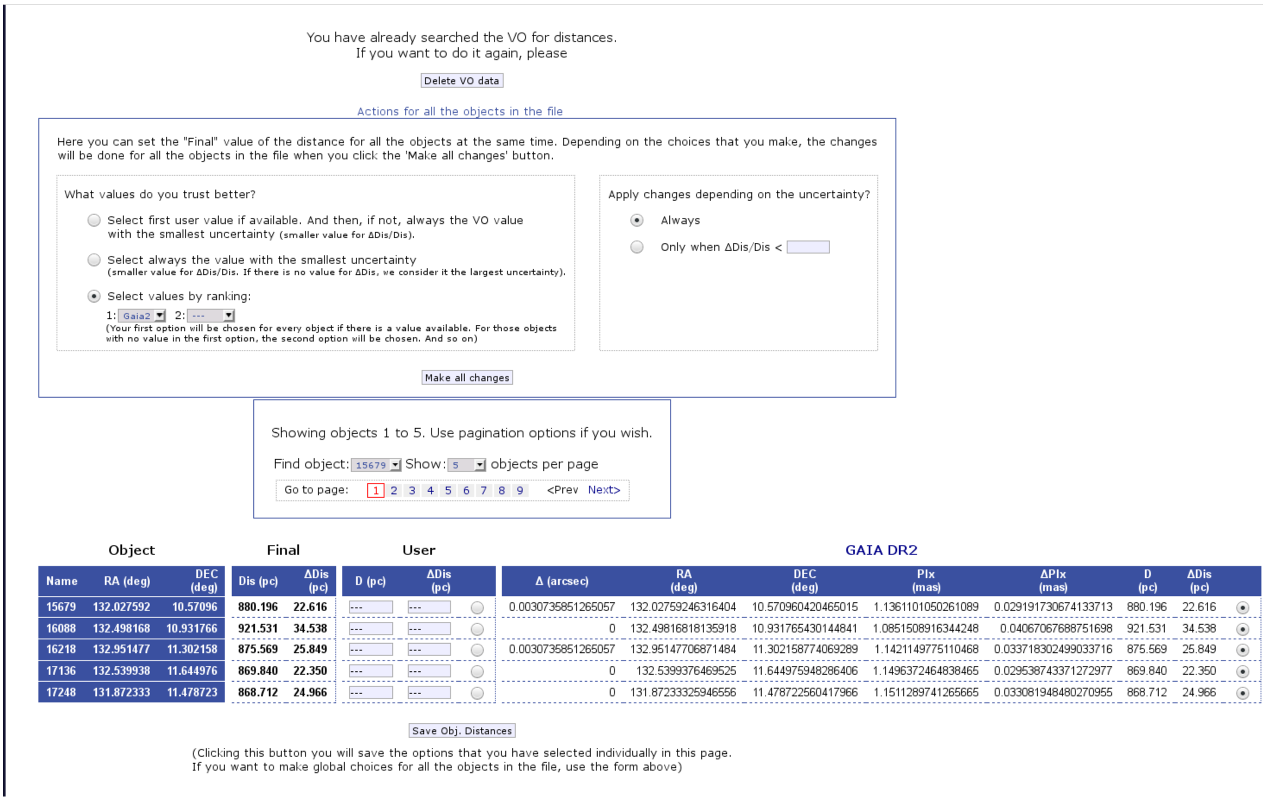
- Tag "Files"

  - Step 3.- Upload the vosa_nice.*txt* file in VOSA (“File to upload”). It contains a subset (45 objects) of the orginal *clusterix4vosa.txt* file. We work with this subset in order to speed up the workflow. The file vosa_nice.*txt* is available from the web page of the school.

    Give a description (free text). And then, click “Upload” (do not bother about the File type). The message “*your- file-name has been succesfully uploaded!”* will appear. Click “Continue”. If the message does not appear, go to “your files” section and click “Select”.

- Tag "Objects"

  - Step 4.- Place the cursor on the*“Objects”* tag and then click *“Distances”*. Click *“Search for Obj. Distances”.* To make the Gaia DR2 distances the “final” distances, do the following: Go to the *“Actions for all the objects in the file”* panel, tick *“Select values by ranking”* and choose Gaia2 in the first place. Click *“Make all changes”*. The Gaia DR2 coordinates will appear in bold in the “Final” column. (Figure 12)



You have already searched the VO for distances.
If you want to do it again, please

Delete VO data

Actions for all the objects in the file

Here you can set the "Final" value of the distance for all the objects at the same time. Depending on the choices that you make, the changes will be done for all the objects in the file when you click the 'Make all changes' button.

What values do you trust better?

- Select first user value if available. And then, if not, always the VO value with the smallest uncertainty (smaller value for ΔDis/Dis).
- Select always the value with the smallest uncertainty (smaller value for ΔDis/Dis. If there is no value for ΔDis, we consider it the largest uncertainty).
- Select values by ranking:
  1: Gaia2 2: ---
  (Your first option will be chosen for every object if there is a value available. For those objects with no value in the first option, the second option will be chosen. And so on)

Apply changes depending on the uncertainty?

- Always
- Only when ΔDis/Dis <

Make all changes

Showing objects 1 to 5. Use pagination options if you wish.

Find object: 15679 Show: 5 objects per page

Go to page: 1 2 3 4 5 6 7 8 9 <Prev Next>

Object			Final		User		GAIA DR2						
Name	RA (deg)	DEC (deg)	Dis (pc)	ΔDis (pc)	D (pc)	ΔDis (pc)	Δ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	ΔPlx (mas)	D (pc)	ΔDis (pc)
15679	132.027592	10.57096	**880.196**	**22.616**	---	---	0.0030735851265057	132.02759246316404	10.570960420465015	1.1361101050261089	0.029191730674133713	880.196	22.616
16088	132.498168	10.931766	**921.531**	**34.538**	---	---	0	132.49816818135918	10.931765430144841	1.0851508916344248	0.040670676887516 98	921.531	34.538
16218	132.951477	11.302158	**875.569**	**25.849**	---	---	0.0030735851265057	132.95147706871484	11.302158774069289	1.1421149775110468	0.033718302499033716	875.569	25.849
17136	132.539938	11.644976	**869.840**	**22.350**	---	---	0	132.5399376469525	11.644975948286406	1.1496372464838465	0.029538743371272977	869.840	22.350
17248	131.872333	11.478723	**868.712**	**24.966**	---	---	0	131.87233325946556	11.478722560417966	1.1511289741265665	0.033081948480270955	868.712	24.966

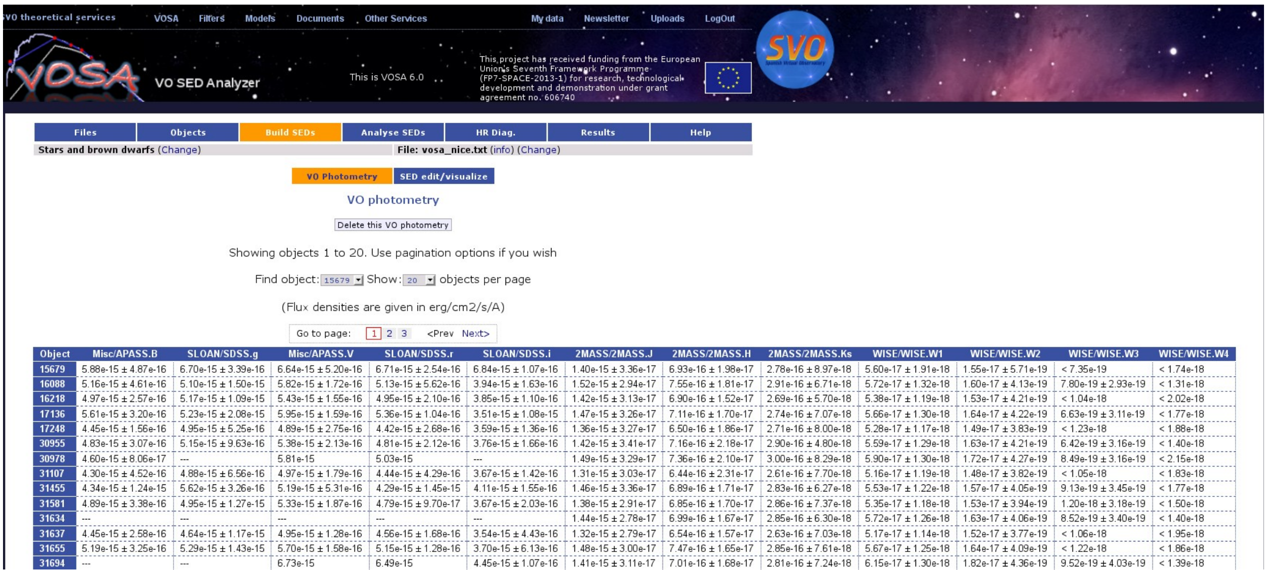
Save Obj. Distances

(Clicking this button you will save the options that you have selected individually in this page.
If you want to make global choices for all the objects in the file, use the form above)

Figure 12.

- Tag “Build SEDs”

  - Step 5.- Place the cursor on the *“Build SEDs” tag* and then click *“VO photometry”.* Here we will be able to look for phometric information of our objects in different VO catalogues. In order not to slow down too much the tutorial, click *“unmark All”* and select only 2MASS, WISE and APASS9. Then, click *"Query selected services"* at the bottom of the page. Once this is done, a summary table with the VO photometry (in flux units) will appear (Figure 13).

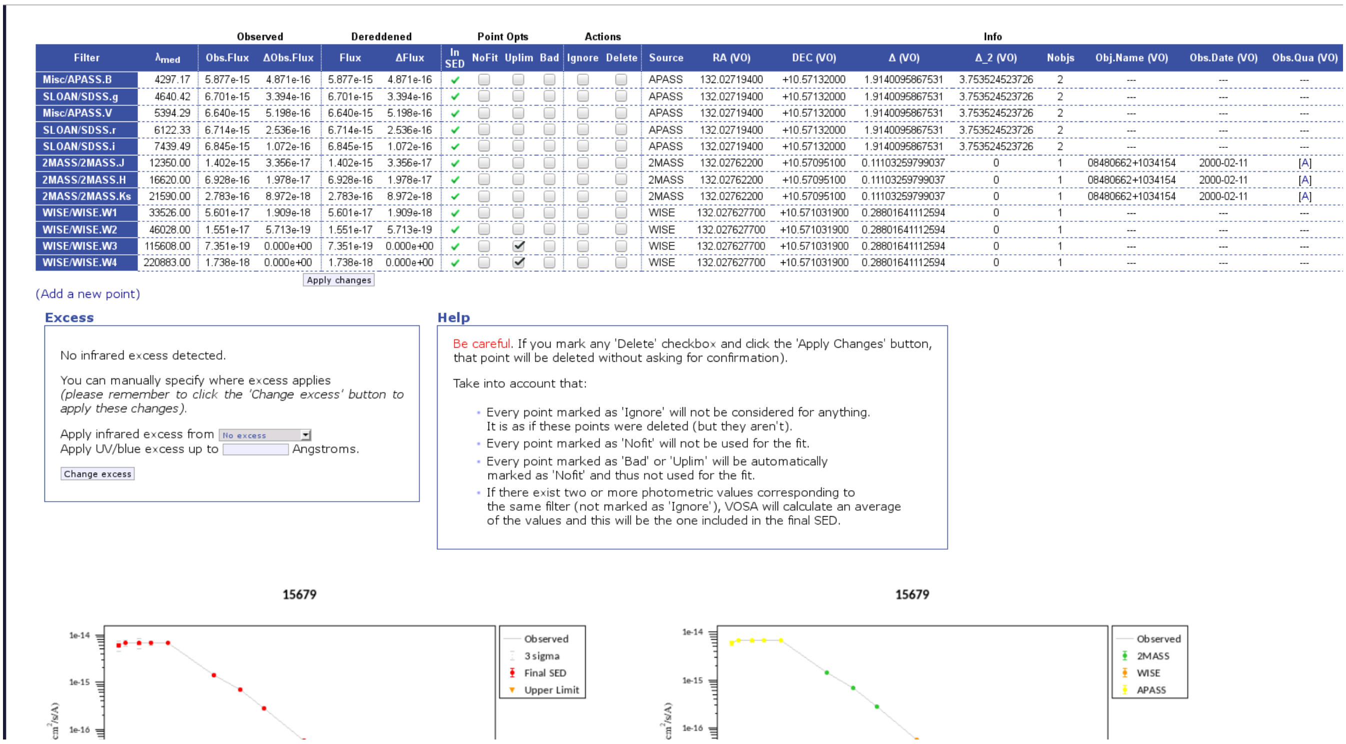


Object	Misc/APASS.B	SLOAN/SDSS.g	Misc/APASS.V	SLOAN/SDSS.r	SLOAN/SDSS.i	2MASS/2MASS.J	2MASS/2MASS.H	2MASS/2MASS.Ks	WISE/WISE.W1	WISE/WISE.W2	WISE/WISE.W3	WISE/WISE.W4
15679	5.88e-15 ± 4.87e-16	6.70e-15 ± 3.39e-16	6.64e-15 ± 5.20e-16	6.71e-15 ± 2.54e-16	6.84e-15 ± 1.07e-16	1.40e-15 ± 3.36e-17	6.93e-16 ± 1.98e-17	2.78e-16 ± 8.97e-18	5.60e-17 ± 1.91e-18	1.55e-17 ± 5.71e-19	< 7.35e-19	< 1.74e-18
16088	5.16e-15 ± 4.61e-16	5.10e-15 ± 1.50e-15	5.82e-15 ± 1.72e-16	5.13e-15 ± 5.62e-16	3.94e-15 ± 1.63e-16	1.52e-15 ± 2.94e-17	7.55e-16 ± 1.81e-17	2.91e-16 ± 6.71e-18	5.72e-17 ± 1.32e-18	1.60e-17 ± 4.13e-19	7.80e-19 ± 2.93e-19	< 1.31e-18
16218	4.97e-15 ± 2.57e-16	5.17e-15 ± 1.09e-15	5.43e-15 ± 1.55e-16	4.95e-15 ± 2.10e-16	3.85e-15 ± 1.10e-16	1.42e-15 ± 3.13e-17	6.90e-16 ± 1.52e-17	2.69e-16 ± 5.70e-18	5.38e-17 ± 1.19e-18	1.53e-17 ± 4.21e-19	< 1.04e-18	< 2.02e-18
17136	5.61e-15 ± 3.20e-16	5.23e-15 ± 2.08e-15	5.95e-15 ± 1.59e-16	5.36e-15 ± 1.04e-16	3.51e-15 ± 1.08e-15	1.47e-15 ± 3.26e-17	7.11e-16 ± 1.70e-17	2.74e-16 ± 7.07e-18	5.66e-17 ± 1.30e-18	1.64e-17 ± 4.22e-19	6.63e-19 ± 3.11e-19	< 1.77e-18
17248	4.45e-15 ± 1.56e-16	4.95e-15 ± 5.25e-16	4.89e-15 ± 2.75e-16	4.42e-15 ± 2.68e-16	3.59e-15 ± 1.36e-16	1.36e-15 ± 3.27e-17	6.50e-16 ± 1.86e-17	2.71e-16 ± 8.00e-18	5.28e-17 ± 1.17e-18	1.49e-17 ± 3.83e-19	< 1.23e-18	< 1.88e-18
30955	4.83e-15 ± 3.07e-16	5.15e-15 ± 9.63e-16	5.38e-15 ± 2.13e-16	4.81e-15 ± 2.12e-16	3.76e-15 ± 1.66e-16	1.42e-15 ± 3.41e-17	7.16e-16 ± 2.18e-17	2.90e-16 ± 4.80e-18	5.59e-17 ± 1.29e-18	1.63e-17 ± 4.21e-19	6.42e-19 ± 3.16e-19	< 1.40e-18
30978	4.60e-15 ± 8.06e-17	---	5.81e-15	5.03e-15	---	1.49e-15 ± 3.29e-17	7.36e-16 ± 2.10e-17	3.00e-16 ± 8.29e-18	5.90e-17 ± 1.30e-18	1.72e-17 ± 4.27e-19	8.49e-19 ± 3.16e-19	< 2.15e-18
31107	4.30e-15 ± 4.52e-16	4.88e-15 ± 6.56e-16	4.97e-15 ± 1.79e-16	4.44e-15 ± 4.29e-16	3.67e-15 ± 1.42e-16	1.31e-15 ± 3.03e-17	6.44e-16 ± 2.31e-17	2.61e-16 ± 7.70e-18	5.16e-17 ± 1.19e-18	1.48e-17 ± 3.82e-19	< 1.05e-18	< 1.83e-18
31455	4.34e-15 ± 1.24e-15	5.62e-15 ± 3.26e-16	5.19e-15 ± 5.31e-16	4.29e-15 ± 1.45e-15	4.11e-15 ± 1.55e-16	1.46e-15 ± 3.36e-17	6.89e-16 ± 1.71e-17	2.83e-16 ± 6.27e-18	5.53e-17 ± 1.22e-18	1.57e-17 ± 4.05e-19	9.13e-19 ± 3.45e-19	< 1.77e-18
31581	4.89e-15 ± 3.38e-16	4.95e-15 ± 1.27e-15	5.33e-15 ± 1.87e-16	4.79e-15 ± 9.70e-17	3.67e-15 ± 2.03e-16	1.38e-15 ± 2.91e-17	6.85e-16 ± 1.70e-17	2.86e-16 ± 7.37e-18	5.35e-17 ± 1.18e-18	1.53e-17 ± 3.94e-19	1.20e-18 ± 3.18e-19	< 1.50e-18
31634	---	---	---	---	---	1.44e-15 ± 2.78e-17	6.99e-16 ± 1.67e-17	2.85e-16 ± 6.30e-18	5.72e-17 ± 1.26e-18	1.63e-17 ± 4.06e-19	8.52e-19 ± 3.40e-19	< 1.40e-18
31637	4.45e-15 ± 2.58e-16	4.64e-15 ± 1.17e-15	4.95e-15 ± 1.28e-16	4.56e-15 ± 1.68e-16	3.54e-15 ± 4.43e-16	1.32e-15 ± 2.79e-17	6.54e-16 ± 1.57e-17	2.63e-16 ± 7.03e-18	5.17e-17 ± 1.14e-18	1.52e-17 ± 3.77e-19	< 1.06e-18	< 1.95e-18
31655	5.19e-15 ± 3.25e-16	5.29e-15 ± 1.43e-15	5.70e-15 ± 1.58e-16	5.15e-15 ± 1.28e-16	3.70e-15 ± 6.13e-16	1.48e-15 ± 3.00e-17	7.47e-16 ± 1.65e-17	2.85e-16 ± 7.61e-18	5.67e-17 ± 1.25e-18	1.64e-17 ± 4.09e-19	< 1.22e-18	< 1.86e-18
31694	---	---	6.73e-15	6.49e-15	4.45e-15 ± 1.07e-16	1.41e-15 ± 3.11e-17	7.01e-16 ± 1.68e-17	2.81e-16 ± 7.24e-18	6.15e-17 ± 1.30e-18	1.82e-17 ± 4.36e-19	9.52e-19 ± 4.03e-19	< 1.39e-18

Figure13

- Step 6.- Place the cursor on the *"Build SEDs" tag* and then click *"SED edit/visualize".* This tag gives us the possibility of visualising/modifying the SED before the model fitting. VOSA gathers from VO services not only the photometric information but also different metadata of interest (Object name, observing date and information on quality). In particular, VOSA uses the information on quality to automatically identify bad photometric points and remove them from the fitting. Upper limits are treated in a similar way (see, for instance, WISE W3 and W4 for object "15679"). The user can manually override this selection of photometric points by ticking/unticking the appropriate boxes. (Figure 14)

For this use case, do not make any change in the SED edit/visualize section.



Filter	λ_{med}	Observed: Obs.Flux	Observed: ΔObs.Flux	Dereddened: Flux	Dereddened: ΔFlux	Point Opts: In SED	Point Opts: NoFit	Point Opts: Uplim	Point Opts: Bad	Actions: Ignore	Actions: Delete	Info: Source	RA (VO)	DEC (VO)	Δ (VO)	Δ_2 (VO)	Nobjs	Obj.Name (VO)	Obs.Date (VO)	Obs.Qua (VO)
Misc/APASS.B	4297.17	5.877e-15	4.871e-16	5.877e-15	4.871e-16	✓	☐	☐	☐	☐	☐	APASS	132.02719400	+10.57132000	1.9140095867531	3.753524523726	2	---	---	---
SLOAN/SDSS.g	4640.42	6.701e-15	3.394e-16	6.701e-15	3.394e-16	✓	☐	☐	☐	☐	☐	APASS	132.02719400	+10.57132000	1.9140095867531	3.753524523726	2	---	---	---
Misc/APASS.V	5394.29	6.640e-15	5.198e-16	6.640e-15	5.198e-16	✓	☐	☐	☐	☐	☐	APASS	132.02719400	+10.57132000	1.9140095867531	3.753524523726	2	---	---	---
SLOAN/SDSS.r	6122.33	6.714e-15	2.536e-16	6.714e-15	2.536e-16	✓	☐	☐	☐	☐	☐	APASS	132.02719400	+10.57132000	1.9140095867531	3.753524523726	2	---	---	---
SLOAN/SDSS.i	7439.49	6.845e-15	1.072e-16	6.845e-15	1.072e-16	✓	☐	☐	☐	☐	☐	APASS	132.02719400	+10.57132000	1.9140095867531	3.753524523726	2	---	---	---
2MASS/2MASS.J	12350.00	1.402e-15	3.356e-17	1.402e-15	3.356e-17	✓	☐	☐	☐	☐	☐	2MASS	132.02762200	+10.57095100	0.11103259799037	0	1	08480662+1034154	2000-02-11	[A]
2MASS/2MASS.H	16620.00	6.928e-16	1.978e-17	6.928e-16	1.978e-17	✓	☐	☐	☐	☐	☐	2MASS	132.02762200	+10.57095100	0.11103259799037	0	1	08480662+1034154	2000-02-11	[A]
2MASS/2MASS.Ks	21590.00	2.783e-16	8.972e-18	2.783e-16	8.972e-18	✓	☐	☐	☐	☐	☐	2MASS	132.02762200	+10.57095100	0.11103259799037	0	1	08480662+1034154	2000-02-11	[A]
WISE/WISE.W1	33526.00	5.601e-17	1.909e-18	5.601e-17	1.909e-18	✓	☐	☐	☐	☐	☐	WISE	132.027627700	+10.571031900	0.28801641112594	0	1	---	---	---
WISE/WISE.W2	46028.00	1.551e-17	5.713e-19	1.551e-17	5.713e-19	✓	☐	☐	☐	☐	☐	WISE	132.027627700	+10.571031900	0.28801641112594	0	1	---	---	---
WISE/WISE.W3	115608.00	7.351e-19	0.000e+00	7.351e-19	0.000e+00	✓	☐	✓	☐	☐	☐	WISE	132.027627700	+10.571031900	0.28801641112594	0	1	---	---	---
WISE/WISE.W4	220883.00	1.738e-18	0.000e+00	1.738e-18	0.000e+00	✓	☐	✓	☐	☐	☐	WISE	132.027627700	+10.571031900	0.28801641112594	0	1	---	---	---

Figure 14.

- Tag “Analyse SEDs”

  - Step 7: Place the cursor on the *“Analyse SEDs” tag* and then click *“Chi-square fit”.* Different grids of theoretical models covering different ranges of physical parameters are displayed. For this tutorial select only the “Kurucz ODFNEW /NOVER models”. Click *“Next: Select mode params”.* (Figure 15).

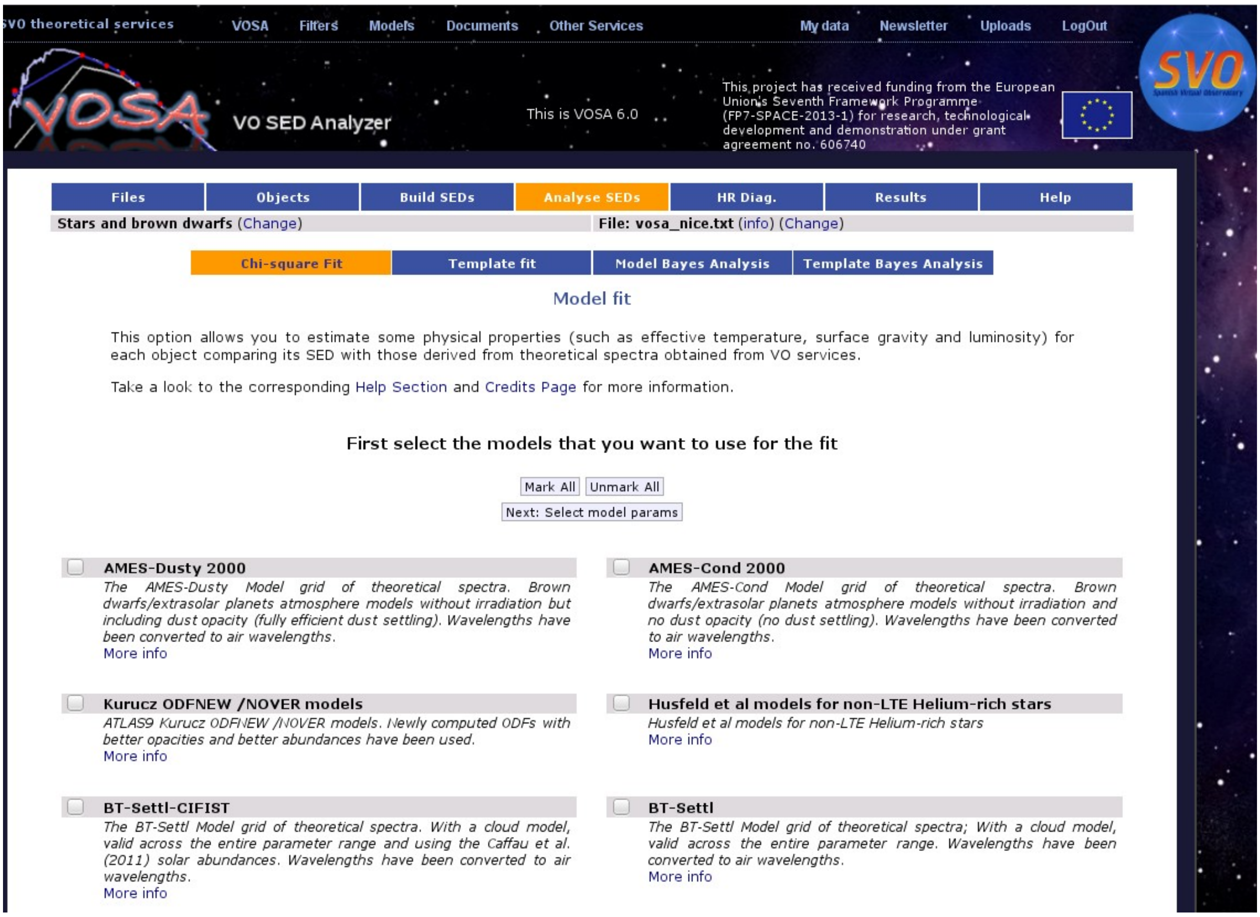
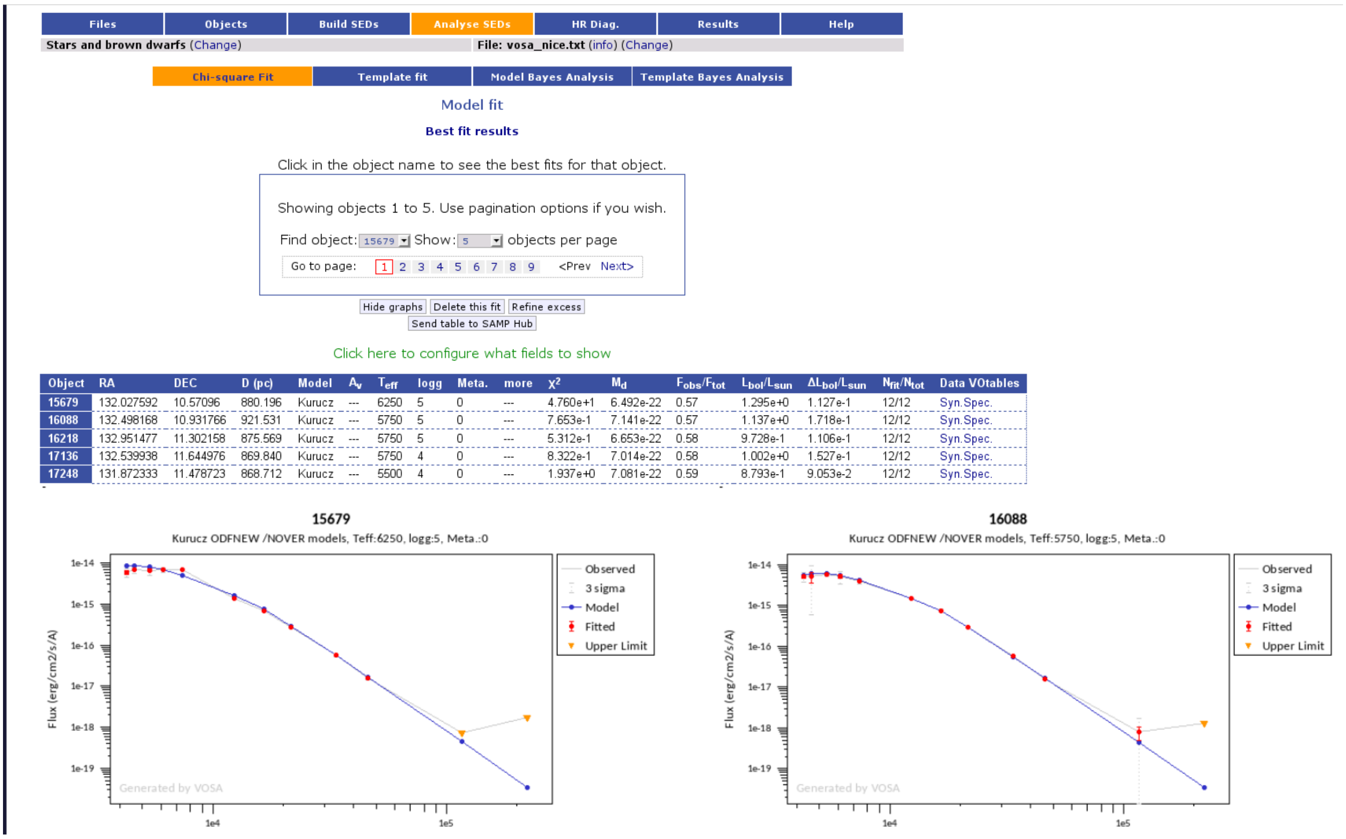


Figure 15

  - Step 8.- In this window, we can limit the range of physical parameters that will be used for the fit. To save time we will make the following assumptions:
    - Teff: 4000-8000K
    - logg: 4.0-5.0 dex.
    - [M/H]=0.0

    Then, click *“Make the fit”*

  - Step 9.- We will see now a summary table with the best fit results. Click on “Show graphs” to have a look at the graphics. The table can be sent to TOPCAT using the “Send Table to SAMP hub” button. (Figure 16).



Object	RA	DEC	D (pc)	Model	A_V	T_{eff}	logg	Meta.	more	χ^2	M_d	F_{obs}/F_{tot}	L_{bol}/L_{sun}	$\Delta L_{bol}/L_{sun}$	N_{fit}/N_{tot}	Data VOtables
15679	132.027592	10.57096	880.196	Kurucz	---	6250	5	0	---	4.760e+1	6.492e-22	0.57	1.295e+0	1.127e-1	12/12	Syn.Spec.
16088	132.498168	10.931766	921.531	Kurucz	---	5750	5	0	---	7.653e-1	7.141e-22	0.57	1.137e+0	1.718e-1	12/12	Syn.Spec.
16218	132.951477	11.302158	875.569	Kurucz	---	5750	5	0	---	5.312e-1	6.653e-22	0.58	9.728e-1	1.106e-1	12/12	Syn.Spec.
17136	132.539938	11.644976	869.840	Kurucz	---	5750	4	0	---	8.322e-1	7.014e-22	0.58	1.002e+0	1.527e-1	12/12	Syn.Spec.
17248	131.872333	11.478723	868.712	Kurucz	---	5500	4	0	---	1.937e+0	7.081e-22	0.59	8.793e-1	9.053e-2	12/12	Syn.Spec.

Figure 16

To get information on the radii derived from VOSA, click *"Click here to configure what fields to show"* and tick R1 and R2. Click *"Save config."* Radii obtained using two different approaches will now appear in the summary table. More information on how VOSA calculates radii can be found at:
http://svo2.cab.inta-csic.es/theory/vosa/helpw4.phpotype=star&action=help&what=fit#fit:radius